The Effect of Music on Physical Productivity

A Senior Honors Thesis

Presented in Partial Fulfillment of the Requirements for graduation *with research distinction in Psychology* in the undergraduate colleges of The Ohio State University

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February 2010

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Abstract

Different features of music have been shown to have large effects on human behavior from mood to endurance. What is yet to be determined is how music similarly affects movement speed by keeping time, or synchronizing, with the beat. To examine this concept, the present study used 70 college students completing two tasks while listening to fast music, slow music, or white noise to determine if tempo changes movement speed while walking up stairs. Additionally, I examined whether differences in music tempo would affect how many times subjects would squeeze a hand gripper. Although no effects were found for the hand gripper task, results showed that those in the fast paced condition walked up the stairs significantly faster than those in the slow condition. There was also a correlation between the amount that subjects reported that music affects their lives and how fast they walked in the fast music condition. These findings have implications for the workforce, athletic training, sports training, and rehabilitation for physically debilitating diseases.

The Effects of Music on Physical Productivity

Have you ever wondered why you find yourself tapping your foot along with a beat or why music can instantly change your mood? If you have, you have probably wondered why these behaviors seem to happen automatically. The influence music can have on behavior has also been of interest to many different fields of psychology over the years. Although music's influence on behavior is a popular topic in psychology, it has been rather difficult to study because of its subjective nature. Much of the research has dealt with moods, personal preferences, and other characteristics that are typically challenging to measure scientifically. Despite this difficulty, psychologists have found that many common assumptions about music are true. For example, it has been shown in numerous studies that music can impact our mood and create emotional states such as eliciting happier responses when faster music is played (Webster & Weir, 2005). However, the structural aspects of music, such as tempo, and physical aspects of human behavior, such as walking speed, have been largely neglected. Understanding how music can affect our physical movements may have implications for many different fields including sports psychology, physical rehabilitation, and workforce production.

This document aims to show how playing a selection of fast music can alter the speed of movement in the things we do in everyday life such as our jobs, workouts, and other forms of productive movement. The majority of research in this area tends to be field studies and therefore may have an array of confounding factors. Although the question of how music affects human behavior has been studied in a variety of ways, many researchers still disagree on whether or not the speed of music really does alter the speed of a person's movement because of opposing results. Therefore, it is important to study this question in a way that eliminates personal preference and outside factors as much as possible. Because there are many different kinds of

music genres and styles that speak to different people and affect them in different ways, it is equally important to look at how one specific aspect of music (tempo) can affect a specific aspect of movement (speed) in order to see how they relate to and influence one another.

The present study will be able to provide an accurate answer by providing a basic lab environment that experimentally controls for work habits or an athlete's speed, competitive drive, personal music preference, etc. The following sections will examine research in fields such as sports and social psychology as well as neurobiology that provide a foundation for the hypotheses of this study. I will first discuss how music has a general tendency to affect movements simply by listening to it as opposed to not listening to it. Second, I will explore what component of music may result in an increase in effort through speed and why synchronization may play a part. After providing supporting evidence for the influence of music on movement speed, the third section will introduce similar automatic responses to those that I expect to find that influence speed through music and mental states. These studies show that speed can easily be altered by a variety of cognitive stimuli. Finally, I will discuss the results of field studies that claim music has no effect on movement and some reasons why they did not find a relationship despite evidence that would suggest otherwise.

Music During Workouts

The field of sports psychology has taken particular interest in how music affects an athlete's performance. Many athletes report using music as a motivational tool before competition, and some claim that it makes them work harder (Gluch, 1993). As the never ending goal is to continuously make athletes faster, stronger, and more durable, it is not surprising that psychologists and physical trainers have sought to explore this claim. Although personal

preference comes into play, research in this area has confirmed this claim and shown the benefits of listening to music while working out (Crust & Clough, 2006; Edworthy and Waring, 2006).

What may be the most consistent of these benefits is how music can distract our attention. Music can act as an effective distracter by taking attention off of the work a person is doing. By overflowing attention channels with too much information (i.e. music), there is not room to focus as much attention on the pain or tension that exercise produces, which in turn causes people to rate their perceived exertion much lower. These disparities between how much work people are actually doing and how much they think they are doing could allow people to perform at the same level of physical exertion for longer periods of time (Crust & Clough, 2006).

As well as increasing endurance, people also expend more effort when listening to music that speeds up. Edworthy and Waring (2006) found that using a slow to fast tempo combination in their treadmill study actually caused people to perform at a higher heart rate than slow or no music conditions. It is clear that these effects increase endurance by either making people want to work harder or subconsciously making the body work harder. The next section will address what specific aspects of music may be responsible for the effects of music on performance.

Synchronous Music and Movements

Although music has been shown to be a contributor to an effective workout, simply the presence versus the absence of music cannot be fully responsible for the increased effort when listening to music during exercise. For example, though music may act as a distracter, it seems quite counterintuitive that listening to a ballad would make a person work harder. On the contrary, it would make more sense that the person would feel relaxed. For this reason, it seems that some other factors must be involved and evidence has suggested that music synchrony may

be one of those factors. If music is synchronous to the specific movement, it could be used as an external and possibly unnoticeable cue as to when to move or when to hold back a movement in order to keep with the rhythm. Using music as a cue is already popular in areas such as aerobic exercise and dance, and many workout videos encourage people to stick with the beat. Preferred tempos in such areas seem to revolve around synchrony to the movements of the dance or workout itself (or visa versa). It is true, however, that because people can only move so fast, certain tempos could be too slow or too fast and make it harder to stay in time. If people cannot move as fast as the tempo, it may cause them to rely on half beats and actually slow down their movements even though the beat is faster.

This preference for synchronous versus asynchronous music during movement can be found across all cultures and at a very early developmental stage. For instance, people of all ages, including infants with no previous practice, can distinguish between duple and triple meters if they are able to use movement as a physical representation of the beat (Phillips-Silver & Trainor, 2005) and even before the age of one it is not uncommon for babies to bounce along to the beat of music on their own. Because this is something that happens at about the same developmental period all over the world we could consider moving to the beat and using beats as cues an instinctual pattern rather than something that is purely learned.

If an instinctual pattern can be assumed, it is important to find what part of the brain is responsible for this natural ability. Evidence from an fMRI study conducted by Chen, Penhune, and Zatorre (2008) shows that although many parts of the brain are involved in motor activity, some regions accommodate both synchronous movement and rhythm pattern differentiation. Specifically, they found that the dorsal premotor cortex was activated while tapping to the beat. This area is known not only for anticipatory movement but also for organizing metical rhythms.

They concluded that although previous research seemed to show the motor cortex as only executing tasks related to movement, it was also activated while listening to rhythms in anticipation of movement, showing that a musical beat may provide an unconscious cue to speed as they plan to move. This connection is also found in a study by Phillips-Silver and Trainor (2005). These researchers found that physical movement influenced metrical interpretation of an ambiguous beat in tapping patterns. Subjects were asked to move to either a triple or duple beat for the first part of the study. While listening to an ambiguous beat in the second part of the study, they were sure that the ambiguous beat was in a duple or triple meter according to their previous moving condition. This finding shows that not only does the music tempo influence movement, but rhythmical movement can also bias thoughts and create metrical interpretation in music when there are none.

What may be the most convincing evidence for using music as cues for movement are studies on patients with Parkinson's disease. Bradykinesia is a symptom of Parkinsons's disease that slows the ability to start and continue movements, and causes an impaired ability to adjust the body's position. This deficit is thought to be caused by impairment in the basal ganglia that slows preparation to execute movements (Berardelli, Rothwell, Thompson, & Hallett, 2001). If such individuals do perform the activity, it is often very rigid and unsteady. However, using a metrical rhythm seems to help patients in rehab walk smoother. Six patients were tested while listening to a rhythm of a pure tone at 100 beats per minute. All participants showed an improvement and walking was both less rigid and at a steadier pace (Olmo & Cudeiro, 2003).

Evidence shows that perceived rhythms are influenced by movement and movement is likewise influenced by perceived rhythms. According to neurobiological evidence, if given a rhythm, the brain should process its interpretation of this rhythm and will then ready the body for

movement. From behavior favoring certain rhythms during activities, such as dance and aerobic exercise, it is clear that a specific, and synchronized, type of rhythm is preferred over others, indicating that comfortable cues for movement are important and much easier to carry out than rhythms that are asynchronous. Because a mutual relationship is found between movement and rhythm, it seems that these may serve a purpose when listening to music during physical movement and that following a cue during repetitive motions would be more comfortable than going against it.

Elicited Automatic Responses

Although in this review of the literature on music and speed studies have shown that using emotional states does not influence performance on a significant level, it is true that these emotional states are one way that music influences the perception of speed. Music could produce these states if structural aspects of music or lyrics bring to mind an event that is associated with the emotion (Bishop et al., 2007). For example, faster music has been shown to produce happier responses while slower music provides the opposite reaction (Webster & Weir, 2005). Producing this emotion in people may be related to how fast they perceive time to go by. Blood and Ferris (1993) demonstrated how music can bring about happy and sad emotions and how these emotions can alter perceived speed. In their study, participants were tested on their perceived speed of conversation when in the presence of background music. Researchers found that those who listened to fast music in a major mode, suggestive of happier moods, thought a) they talked faster, b) their partner talked faster, and c) the conversation subjects went faster as opposed to the slow music in a major mode.

The suggestion that music tempo may affect movement speed seems possible as movement speed can be altered through other cognitive stimuli. Even such unrelated factors as priming can affect walking speed. Bargh, Chen and Burrows, (1996) demonstrated this using common stereotypes. Participants were tested to see if using priming effects would change walking speed by introducing thoughts that most people would associate with elderly people. They found that participants in a priming condition designed to promote elderly stereotypes without mentioning words that suggested slowness subsequently walked slower down a hallway than those in a neutral priming condition.

These studies show that music has already been shown to be effective in changing the perception of speed (Webster & Weir, 2005), and that other cognitive stimuli have successfully altered movement speed (Bargh et al., 1996). Because mental states have been able to change speed and music has been shown to create mental states, we could guess that physical speed could be altered by music as well.

Field Studies

Field studies make up the bulk of research on the effectiveness of music on work output. Some field studies involving music and speed have found that music seems to have no effect on our everyday movements. This seems to be counterintuitive given that even at a very young age babies can move to a beat without any coaxing. As people grow older many still prefer to have music playing when trying to get a job done or while working out. Because these common behaviors and observation shows that music does affect us, it seems these studies may have uncontrollable factors that clouded results.

Examples of such research involving music and movement are in field studies in the workforce. Researchers in this area have continuously tried to find a way to introduce music to benefit employees, increase production, and influence consumers. Interest in music and its effects on job satisfaction and production began in the 1950's. Studies then showed that when music was played, employee moods and overall production went up (Oldham, Cummings, Mischel, Schmidtke, & Zhou, 1995). Recent studies, however, seem to show that music is not much more than a distraction at work (Furnham & Bradley, 1997). These results are intuitive for workplaces that require cognitive processes, but those that are physical have yet to be examined in a way that would show results. For example, a study by Hsieh and Kline (2003) looked at the effects of music during work hours using hotel attendants to see if playing music in the rooms they were cleaning increased the number of rooms they cleaned without sacrificing the quality of work. Although they found that the music had no effect, it is possible that this could be because workers have already established a speed that they regularly work which would not be affected by one day of listening to music.

Similarly, much of the research involving music in sports psychology has been field research. In these environments it would be hard to determine how much of the effect was due to the athlete's natural competitiveness and talent or training schedules. Though there are many complications in conducting research in field settings, many have attempted to understand the relationship between athletes and their precompetitive music selections. Psychologists looking to increase ability in athletes have based their research on the emotional state that is initiated when listening to certain music. Music has been shown to trigger feelings and events that boost hormones associated with emotional states (Bishop, Karageorghis, & Kinrade, 2007). In an athletic setting, researchers aim to activate those emotions associated with feelings such as

confidence and motivation, which would seem to be helpful in a competitive event (Bishop, Karageorghis, & Kinrade, 2007). In many cases, however, attempting to understand why music can influence athletes by triggering emotions has proven to be ineffective (Bishop, Karageorghis, & Loizou, 2009). Although in this study the chosen music gave the participant the desired emotions, no relationship was found between reaction time and music related to arousal, excitement, etc. Approaching the connection between an athlete's choice to listen to music before competitive events in a way that only looks at the emotional state the athlete is in fails to take the structural aspects of music into account. Studies that have looked at these structural aspects have used music tempo to trigger a motivational state rather than look at how tempo affects the motor movement without emotional levels involved.

Research Goals and Hypotheses

The goal of this research is to examine how different tempos in music can affect basic levels of motor activity while controlling for confounding factors that can arise when studying in a strict rule environment such as work habits and competitive motivation. This study looks to examine only one of the intrinsic features of music (tempo) which could cause a change in the speed of an activity while controlling for volume and as many personal and emotional factors as possible by playing a tune with no lyrics. Research on behavior has found that music does, in fact, distract people from the messages of discomfort that muscles try to relay to the brain by clogging the attention channels (Crust & Clough, 2006). This, in turn, can cause people to perform longer and perhaps harder (Endworthy & Warring, 2006). Because of increased effort with a perception of less fatigue, it is clear that music has a positive effect on physical activity. However, these studies do not show how speed can be altered or how music tempos play a role.

Further exploring the benefits of music during movement, neuroimaging research has shown numerous links between synchronous rhythm and the premotor cortex. These links indicate that both are involved when planning movement and while listening to rhythmical patterns (Chen, et al., 2008). Parkinson's research shows that metrical tempos can be used as a cue and that hearing a rhythm may instinctually ready the body to move, yet literature in sport and workforce settings have failed to show results in agreement (Olmo & Cudeiro, 2003; Furnham & Bradley, 1997; Bishop et al., 2009). This study will attempt to remove confounding factors such as competitive drives in athletics, high cognitive load in the office, and engrained work habits that may be the reason for the muddled results. In this way we can see the way tempos and synchronous rhythms of music affect our motor activity to help better understand why they make us move even when our movements are not intentional.

By conducting a lab study I hope to see that these effects are real and just hidden, possibly by asynchrony in previous studies' music selections or by the lack of time the participants were exposed to the musical selections when they had to be focused on a particular task. In the present study participants will be asked to do simple activities (i.e. climbing a flight of stairs and squeezing a hand gripper) while listening to fast music, slow music, or white noise to see how the speed of the tasks they perform are affected. The results I expect to find are as follows:

Hypothesis 1: Fast paced musical selections will elicit faster times in the stair climbing task.

Hypothesis 2: Fast paced musical selections will result in more grips in the gripper task, showing that synchrony may be important in manipulating speed with musical tempo.

Method

Participants and Design

Participants for this study consisted of 70 Ohio State students (24 male and 46 female) from the Mansfield campus ranging in age from 18 to 36 years with the average age being 19.6 years. All students were enrolled in an introductory psychology course for partial credit. The number of participants was chosen due to its similarity to other studies of this nature. I used a between-subjects design in which the speed of music was experimentally manipulated with fast-paced, slow-paced, or white noise conditions.

Procedures and Materials

This study was conducted in the psychology lab at the Ohio State University at Mansfield campus which is on the third floor of the building. Participants were recruited through an internet posting (Appendix A) and were able to sign up for a time and dates after showing interest. Upon arrival, participants were told that the study was on distractions and multi-tasking because knowing the true objective could have caused participants to act in an unnatural way and therefore damage the results. They were also informed of the involved risks or discomfort of participating in the stair and gripper task, and that if they felt they could not or did not want to perform the task they were free to leave and would still receive credit. After signing an informed consent form (Appendix B) they were randomly assigned to one of three conditions: fast paced music (n = 23), slow paced music (n = 23), or white noise music (n = 24). They were then led to the floor below to begin the stair task. All orally delivered instructions are described in Appendix C.

Description of Experimental Music. The music selection contained no words. It was a basic instrumental accompaniment on a keyboard with percussion in the background. In both slow and fast paced conditions the same selection was be used with the slow being at 95 beats per minute and the fast paced condition being at 135 beats per minute.

Task 1: The Stair Task. Once the participant reached the stairs, they were told to stay close to the left side of the staircase and to turn the music on from a headset given to them. They were also told to wait until the researcher was at the top of the stairs, and to start walking up the stairs when the researcher held out a thumb at the top of the stairs. This gave ample time for the participant to listen to a portion of the music before beginning the task while the researcher was walking up the stairs. The song that was played had a slow beat, fast beat, or white noise. The original volume was set for each participant but was able to be adjusted to fit the comfort of the participant. At the top of the stairs a researcher used a hidden timer to record the time it took to complete the trial. It was started when the participant took the first step, and was stopped when both feet reached the top step. Times and conditions were recorded (Appendix D). If the participants asked questions about how they should walk up the stairs (fast, slow, etc.) they were be told to walk up however they wanted to. The flight of stairs between the third and fourth floors was chosen because it has the least amount of traffic. The subject was not run unless the stairs were empty.

Task 2: The Gripper Task. The second part of the study looked at the relationship between the beat of the music and squeezing the gripper. After the stair task, the participants were taken into the psychology lab where they again turned on and listened to the headset given

to them. Participants were in the same music condition that they were in for the stair task. White noise was again included as a third comparison condition. Music volume was originally set but the participants were able to adjust it if they felt it was uncomfortable. The same minute of the music was played for each participant and the tempo condition was recorded. Participants were asked to squeeze the gripper for one minute while the music was playing and the amount of times it was squeezed was recorded. Again, if asked how to squeeze the gripper participants were told to squeeze however they wanted to.

Questionnaire. After completing the tasks, participants were then asked to fill out a short questionnaire (Appendix E) asking questions about the importance of music in their lives as well as perceived athleticism, physical fitness, height, and weight. The questionnaire was used in order to see how the impact music had on people correlated with whether the music had an effect on the participants speed in either task (A 1-7 Likert scale with items such as, "How athletic to you consider yourself to be?" was changed to "Athletic" and "How much has music changed your life?" was changed to "MusicLife". Hereafter, these items are referred to by shortened names to simplify presentation). The researcher was not present while they were filling out the questionnaire and no names were recorded in order to obtain answers that were as valid as possible.

Debriefing. After finishing the questionnaire participants completed a short Suspicion Questionnaire where they were asked questions about the study (i.e. "Do you know what the study was about?", "What do you think the hypotheses were?") (Appendix F). They were then told some of the past research, why the study was really done, and what the hypotheses were as

well as given a sheet to take home that included all this information (Appendix G).

Results

The initial analysis looked at the two main hypotheses; that participants would walk up the stairs faster if they were listening to faster paced music, and that they would also squeeze the hand gripper more times at a higher tempo. After the initial analyses were complete, I then looked at whether the questionnaire items described above correlated with either result. Preliminary analyses determined that there were no significant effects involving participant gender or age; hence these variables were excluded from the analyses that follow.

Hypothesis 1

Participants climbed the stairs listening to fast paced music, slow paced music, or white noise and were timed for each condition. Table 1 shows recorded means and standard deviations for each condition. A one-way ANOVA was used to determine significance with an alpha of $p<.05$. The initial analysis showed a main effect between groups, $F(2, 67) = 6.69$, $p = .002$ and a large effect size, $\eta^2 = .17$. Tukey and LSD post hoc tests were conducted to look at the variance between each group. Tukey results were used for analysis (unless otherwise noted) but LSD results were also considered for exploratory purposes to avoid a Type 2 error.

On average, subjects who were in the fast tempo group climbed the stairs 2.42 seconds faster than in the slow group ($p = .002$). Timing for subjects in the slow and fast conditions did not have times significantly different from the control, but there was a clear pattern where the slow condition had the slowest time, the white noise condition in the middle, and the fast paced with the quickest time (see Table 1 for means and standard deviations). The difference between

the fast and white noise conditions approached significance (p = .09). The difference between the white noise and slow conditions also showed the predicted relationship because times in the slow conditions were slightly slower than those in the white noise condition, however this difference was not significant (p = .29). Because the people in the fast condition moved faster than those in the slow condition, results were consistent with the first hypothesis.

Hypothesis 2

To test the second hypothesis, participants squeezed a hand gripper listening to fast paced music, slow paced music, or white noise and the amount of times it was squeezed were recorded. A one-way ANOVA was used to determine significance with alpha = .05. Again, the white noise condition was considered a control group. There was no main effect for the gripper task as no groups number of grips was significantly different from other groups $F(2, 67) = 0.73$, p = .48 and a small effect size, η^2 = .02. Though means seemed to show a pattern at first (see Table 1), the one way ANOVA, Tukey, and LSD tests showed there were no significant differences between groups. Hence, hypothesis 2 was rejected.

Questionnaire Items

To better understand the results of both hypotheses, I then looked to see if the questionnaire items correlated with the increased speed that was found for the fast music condition in the stair climbing task. It was expected that either the amount of impact music had on the participant, or their level of physical fitness and athleticism would correlate with how fast they walked up the stairs or squeezed the hand gripper (the MusicMood question was not analyzed because 65 out of 70 participants answered “yes”). None of the items on athleticism or

physical fitness proved to be a reliable predictor of speed (see Table 2). However, the MusicLife question did significantly predict how much of an effect the music would have on the participants in the stair task $r(70) = .24$, $p = .04$.To further explore this finding, a median split was conducted to see how much the MusicLife question was able to determine the speed in the stair task.

The median split was conducted to see if those that scored themselves higher in how much music effects their lives were more likely to allow the tempo to alter their speed than those who scored themselves lower. The median score for MusicLife was 5 and those that answered 5 were filtered out of this analysis. All subjects who reported above 5 were considered "high" and those who reported below 5 were considered "low". A factorial ANOVA was conducted on the filtered data. Although differences were not significant, there was a pattern suggesting that those who said music had a larger impact on their lives were more affected by the fast music condition than those in the white noise or slow conditions $F(2, 46) = 1.3$, $p = .29$ (see Figure 1). This suggests that people who's lives are strongly affected by music speed up with fast music but do not slow down much from their natural speed when slower music is played.

Suspicion Questionnaire

To make sure participants did not know the true purpose of the study a suspicion questionnaire was used. On the open ended question seven of the 70 participants guessed that the study was about music tempo and/or pace. The pattern of the results remained the same when these participants were excluded from the results.

Discussion

The main goal of this research was to determine whether, and to what extent, the tempo of music affects movement speed in physical activities. Previous research had indicated that movement speed is an area of human behavior that can be affected by many different stimuli, including stereotypical priming and music key (Bargh et al., 1996; Blood et al., 1993). In addition, it had also been shown that music can change the amount of effort that people put into work similar to the task used in this study (the stair task) such as a workout (Crust & Clough, 2006). Because of this evidence I hypothesized that music tempo would also affect speed of movement in everyday activity. Results are consistent with this research as it was found that faster tempos in music do cause people to move faster when doing physical work than if they were listening to slow music. Analyses also showed that there was a slight difference between fast paced music and white noise. Had more people participated there may have been a significant difference between listening to music with a tempo as opposed to white noise.

A second goal was to explore the possibility that synchronization plays a role in how tempo changes movement speed. Previous work has shown that hearing a beat may ready the brain for movement (Chen et al., 2008). It has also been shown that synchronizing to the beat is a natural behavior that people favor (Phillips-Silver et al., 2005). Because synchronization seemed to be connected to using the beat as a movement cue, I hypothesized that a faster tempo would cue people to move faster and therefore grip more times. The individual test of this hypothesis was the gripper task. Although music tempo did not cause people's number of grips to vary significantly, it could be because people were following different beats. Some could have been following on every beat and others on every other beat. It also may be because there was not a clear natural behavior. Power was very low in the control group (see Table 1) so a norm could

not be established. Because most people climb stairs in a rather limited amount of time, the effects for the stair climbing task were clearer than those in the gripper task. However, because individual steps were not correlated with the tempo of the music, it cannot be said that the increased speed was a result of synchronization with the beat. In future studies looking at whether people synchronize consistently to the beat would be a step forward in discovering how music affects movement speed.

The final aim was to pinpoint certain characteristics that could predict how large an effect tempo had on individuals. However, given that only one of these items was significantly correlated with an increase in walking speed, it seems this is a robust effect that holds through differences in personality traits, preferences to music, and physical characteristics. For example, there was no correlation between speed of walking up the stairs and athleticism, perceived physical fitness, weight, height, age, gender, or BMI. This indicates that none of these characteristics would be successful when predicting speed of either task, and that the variance in walking speeds was not caused by how heavy, fit, or competitive people were, but by the music alone. From this we can guess that even the physical stress put on the body when walking up the stairs was slightly ignored by the urge to walk faster to fast paced music, at least in the limited amount of activity as climbing the stairs.

Although items testing physical characteristics, music's overall impact, and mood could not predict how much people were affected by music, it is clear that the perceived amount that music has changed the subjects' lives plays a role in the degree to which speed is altered when listening to music. For those who perceived their lives are more changed, music tempo has a larger effect on how fast they move when listening to fast music. However, it is still important to note that fast music changed climbing speed regardless of whether or not they felt that music had

changed their lives. There was just an exaggerated effect if they scored higher than the median.

The basic design of this study was chosen for exploratory purposes to show a causal relationship between music tempo and movement speed. In typical field studies, it may be difficult to find results when so many other factors were involved. This research overcame these obstacles by using a method that would be as unbiased as possible to outside influences by using neutral music, a regular activity, and by running each subject individually. Finally I used the questionnaire as an extra step to determine that athleticism or the amount of weight a person carried were not altering results. Revealing this effect at such a basic level allows for interpretation of findings as well as further investigation into the area of music and movement. For example, instead of using music to elicit emotions in athletes before a performance, it may be better to have them listen to music while training. Faster tempos could cause them to push themselves to perform at a higher speed while the presence of music would distract their muscles from feeling fatigued. In this case although people would not be able to listen to music during many competitive performances, it may be helpful in building overall speed leading up to the event.

Although this research answers the question of whether music affects our speed in physical movement, understanding how tempo effects movement speed as well as why are still questions that need to be answered. The ability to apply these findings will come from understanding which characteristics cause people to be more or less affected by the music. From this research it is clear that the degree to which people believe music effects their life is correlated with how fast they move when listening to fast music. Creating better items to understand this relationship could explain why an effect was found.

Another question that comes from this research is whether or not the time variance continuously increases. It would be interesting to study how the relationship continues by making subjects do a task for a certain amount of time that was broken up into increments. If each increment was timed, we could see if time increased, stayed the same, varied, for each interval. A decrease in time would suggest that the fast tempo had an increasing effect while a similar time for each would give further evidence that synchrony may be involved for repetitive movements.

Limitations

Although the design was intended to be sound, there were still a few limitations. One limitation that was found throughout this study was the small amount of participants in each condition. Due to a limited amount of time to collect data and only having the ability to have one participant at a time, it was difficult to get a large amount of subjects for each condition. For example, the MusicLife item on the questionnaire showed that the perceived amount music affects subjects' lives was significantly correlated to their speed in the stair task. However, a problem surfaced with these results because times for people who reported "less" in the fast condition walked similar in speed to those who reported "more" in the fast condition. Ideally, people would walk closer to the white noise condition had they perceived their lives to be less changed by music. Also, results suggest that people who thought music affected their lives more were naturally slower than those who thought music did not affect their lives as much, which is unlikely (see Figure 1). Had more participants been used this problem may have been avoided by having a more reliable control.

A second limitation was that the purpose of the study may have been known to some participants. In the open ended question of the suspicion questionnaire (Appendix F) seven of the 70 participants guessed that the study was trying to determine if faster music made their pace faster. In future studies a better story should be used to cover the true aims to get more reliable results.

Being able to generalize findings to everyday activities was also a limitation to this study. To keep variables the same for all subjects, the same music selection was used for both fast and slow conditions for all participants. However, this may have resulted in a smaller response because of personal preference and the selected piece may not have been perceived the same by everyone. Different results may have been found if people were able to pick music they liked that was at the same tempo as the piece used. Similarly, only two tasks were chosen for this study which might not be easily generalized to everyday activities. Using different types of tasks will determine if music affects physical movement in other common activities. Finally, the participants that were used were all college students. Getting results from only one group of people limits the ability to generalize results.

Conclusion

This study was an important step in understanding how music affects movement. Results showed that listening to fast music while doing physical or repetitive movement increases speed. Though it is true that results can be used in fields that rely on speed of specific movements, such as sports and the workforce, they are also easily applied to the everyday set of movements that our lives require. In a time where getting things done faster is a valued skill, understanding how we unconsciously react to different tempos of music can give us a tool that is not only helpful to

our schedules, but can create more time for things in our lives we would rather not do so quickly. So the next time you clean the house, add fast music to the mix and you may get done just a little faster than you thought.

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Table 1

Means and Standard Deviations of Music Speed Conditions by Task

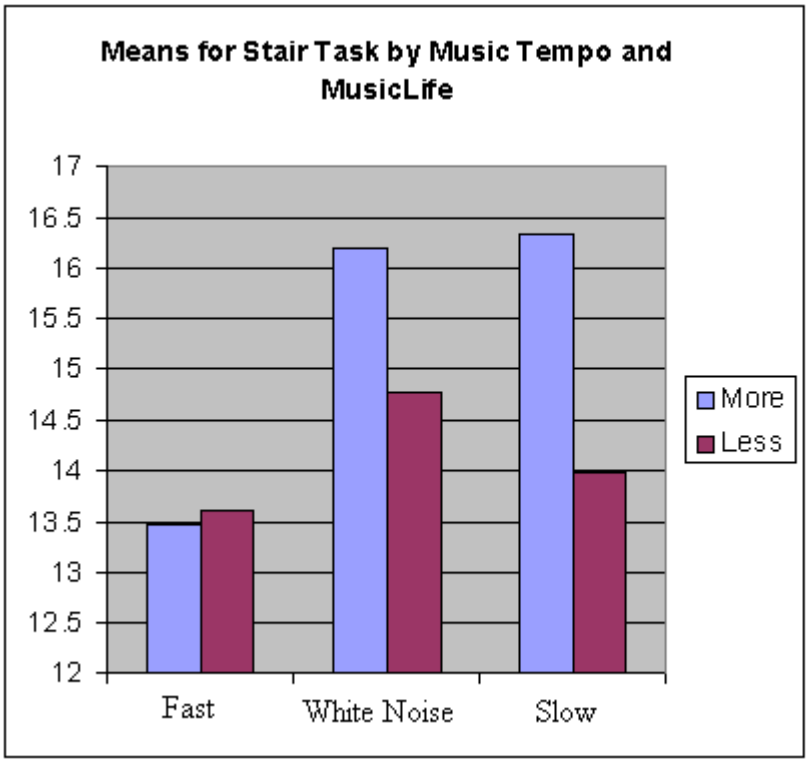
	Stair Climbing Task (secs)		Number of Grips	
	M	*SD*	*M*	*SD*
Fast Music	13.44	1.80	86.04	17.65
Slow Music	15.86	2.66	76.83	29.68
White Noise	14.86	2.23	82.21	28.87

Table 2

Correlation of Questionnaire Items by Task

	Stair Task		Gripper Task	
	r	*p*	*r*	*p*
Athletic	-.11	.38	.001	.99
PhysicallyFit	-.05	.69	.13	.29
MusicEffect	.05	.66	-.16	.20
MusicLife	.24	.04	-.14	.25
MusicMood	-.05	.67	.12	.31
Height	-.01	.92	.05	.71
Weight	.08	.57	-.10	.65
BMI	.10	.43	.14	.27

Figure 1.


Means for Stair Task by Music Tempo and MusicLife
17
16.5
16
15.5
15
14.5
14
13.5
13
12.5
12
Fast
White Noise
Slow
More
Less

Appendices

Appendix A - Internet posting and flier

Psychology Research Participation Opportunity

The aim of this study is to look at how distractions affect the ability to do two things at once (i.e., to multi-task). Specifically, we will be looking at how listening to how music affects certain tasks. You will first be asked to take part in two activities that involve mild everyday physical activities – specifically climbing two flights of steps 2 times, and squeezing a hand gripper for 1 minute. You will then be asked to take a short survey. If you have any questions concerning the study, please e-mail Mariagrace Flint at this email address: flint.31@buckeyemail.osu.edu

****Participants will be asked to do mild physical activity such as climbing stairs and squeezing a hand gripper. If you have any health problems that these activities may interfere with, you are advised NOT to participate****

Appendix B - Consent Form

The Ohio State University Consent to Participate in Research

Study Title: Distractions and Multi-tasking
Researcher: Mariagrace Flint

This is a consent form for research participation. It contains important information about this study and what to expect if you decide to participate.

Your participation is voluntary.

Please consider the information carefully. Feel free to ask questions before making your decision whether or not to participate. If you decide to participate, you will be asked to sign this form and will receive a copy of the form.

Purpose:

The purpose of this study is to examine the process of distraction during multi-tasking activities.

Procedures/Tasks:

You will be asked to take part in two activities that involve mild everyday physical activities – specifically climbing two flights of steps 2 times, and squeezing a hand gripper for 1 minute. You will then be asked to take a short survey about yourself.

Duration:

The study will take approximately 15-20 minutes. You may leave the study at any time. If you decide to stop participating in the study, there will be no penalty to you, and you will not lose any benefits to which you are otherwise entitled (research credit). Your decision will not affect your future relationship with The Ohio State University.

Risks and Benefits:

There are no serious risks associated with this study, however, the two physical activities may cause mild stress and/or physical discomfort. However, you will be able to pace yourself during these activities, so you can slow down or take a break if needed. On the survey, you will have the option to skip any questions you don't want to answer. Your name will not be tied to your data in any way so there are no potential risks to your reputation. You stand to benefit from experiencing first hand how an actual psychology experiment is conducted and learning more about research in this area.

I. Confidentiality:

Every effort will be made to keep your study-related information confidential. However, there may be circumstances where this information must be released. For example, personal information regarding your participation in this study may be disclosed if required by state law. Also, your records may be reviewed by the following groups (as applicable to the research):

- Office for Human Research Protections or other federal, state, or international regulatory agencies;
- The Ohio State University Institutional Review Board or Office of Responsible Research Practices.

Incentives:

You will receive .5 credits towards your Psych 100 class for participating in this study. If you choose to discontinue the study at any time, you will still receive the full .5 credit.

II. Participant Rights:

You may refuse to participate in this study without penalty or loss of benefits to which you are otherwise entitled (research credit). If you are a student or employee at Ohio State, your decision will not affect your grades or employment status.

If you choose to participate in the study, you may discontinue participation at any time without penalty or loss of benefits. By signing this form, you do not give up any personal legal rights you may have as a participant in this study.

An Institutional Review Board responsible for human subjects research at The Ohio State University reviewed this research project and found it to be acceptable, according to applicable state and federal regulations and University policies designed to protect the rights and welfare of participants in research.

III. Contacts and Questions:

For questions, concerns, or complaints about the study you may contact **Mariagrace Flint at flint.31@osu.edu or 419-706-5916 or Phil Mazzocco at mazzocco.6@osu.edu of 419-755-4352**. You can also contact Phil Mazzocco if you feel you have been harmed as a result of taking part in this research study.

For questions about your rights as a participant in this study or to discuss other study-related concerns or complaints with someone who is not part of the research team, you may contact Ms. Sandra Meadows in the Office of Responsible Research Practices at 1-800-678-6251.

IV. Giving Informed Consent

I have read (or someone has read to me) this form and I am aware that I am being asked to participate in a research study. I have had the opportunity to ask questions and have had them answered to my satisfaction. I voluntarily agree to participate in this study.

I am not giving up any legal rights by signing this form.

Please indicate you agreement by choosing “I agree” below:

___I AGREE ___I DISAGREE

Appendix C - Script

(at the outset of the study)

The aim of this study is to look at distractions and how they affect people's ability to do two things at once. This study does involve mild physical activity so if at anytime you feel like you need to stop, you will still receive full credit. First we're going to head downstairs.

(once the participant is downstairs)

Now I'm going to have you stand here while I go back upstairs. Turn the headset on as soon as I walk away and when you see the red flag start walking up the stairs. You can adjust the volume if it is too uncomfortable, but if not please leave it where it is. When you've reached the top of the stairs I'll ask you a couple questions about distractions. Walk up the stairs however you want.

(once the participant is done with the stair climbing)

Did you notice anything out of the corner of your eye?

How many steps do you think you took?

(prior to the hand gripping task)

Now I'll have you take the hand gripper and start squeezing when I say go, and stop when I say stop. Afterwards I will ask you a few questions about distractions. Just squeeze the gripper however you want.

(following the hand gripping task)

Last of all, I'm going to have you fill out a questionnaire. Please answer the questions to the best of your ability.

Appendix D - Stair and Gripper Task Time Sheet

STAIR TASK

TYPE OF MUSIC _____ _____ _____
SLOW FAST NO MUSIC

TIME IN SECONDS _____

GRIPPER TASK

TYPE OF MUSIC _____ _____ _____
SLOW FAST NO MUSIC

NUMBER OF GRIPS _____

Appendix E - Questionnaire

Male _____ Female _____

Age _____

Height_____

Weight_____

Please answer the following to the best of your ability.

How athletic do you consider yourself to be?

1	2	3	4	5	6	7
Not at all Athletic						Extremely Athletic

How physically fit do you consider yourself to be?

1	2	3	4	5	6	7
Not at all Fit						Extremely Fit

How much does music affect you?

1	2	3	4	5	6	7
Not at all						Very Much

How much has music changed your life?

1	2	3	4	5	6	7
Not at all						A Great Deal

Do songs usually change your mood after listening to them? YES_____ NO_____

Appendix F – Suspicion Questionnaire

(on page 1)

What did you think this study was really about?

_____

_____

_____

(on page 2)

Was it about…

A. How having two things to do will make you less efficient at doing one or the other
B. How music can distract you from things in your environment
C. How listening to music can make you fast or slow
D. How music can unknowingly affect your mood

Appendix G - Debriefing Form - Sheet 2

This study looked at how music affects people in everyday or simple activities like you performed here today. We could not tell you this beforehand because we that might have biased your natural responses to music, which would have rendered the results of the study meaningless. Sports and work psychologists are very interested in the effects music has on productivity-a topic that has been studied in both competitive and work environments. Previous studies, however, tend to be very short and in settings where habits and work paces have already been established. Also, the work environments that they have studied have required cognitive tasks, so it is intuitive that music would not be helpful in those situations. We wanted to study the influence of music in a more neutral and novel setting.

We expected that faster paced music would result in faster or more intense motor activity (for example, climbing the steps more quickly or squeezing the hand gripper more times). We expected the opposite for slow music conditions. If you would like to know more about this kind of research, there are some studies listed below that might find interesting. These studies can be obtained through the Ohio State library system.

Please note that it is your right to withdraw your data from further consideration if you so choose (just write mazzocco.6@osu.edu and indicate your desire to have your data removed from further consideration).

We are grateful for your help with this study, and we have one final favor to ask: **please do not talk about the experiment with other people** (especially other students who might be participating in the study in the future). If people come into a study already knowing all about it, it is difficult for them to respond naturally to the experiment and that makes it difficult or impossible for us to learn anything from their responses. We appreciate your assistance in maintaining the scientific integrity of this research.

Feel free to ask the experimenter questions about the study, or to provide feedback. If you are interested in additional information regarding this study, or if you have additional feedback, you can contact the lead researcher: Philip Mazzocco at mazzocco.6@osu.edu or at 419-755-4352.

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Thanks for your participation!